

## PROSPECTIVE OBSERVATIONAL *IN VIVO* STUDY ON ZIRCONIA AND TITANIUM DENTAL IMPLANTS IN AN INDIAN CONTEXT

ANOOP NAIR<sup>1</sup>, RESHMA KULKARNI<sup>2</sup>, KIRAN KUMAR<sup>3</sup> & D. R PRITHVIRAJ<sup>4</sup>

<sup>1, 2</sup> Assistant Professor Department of Prosthodontics Government Dental College, Bangalore

<sup>3</sup> Associate Professor Department of Conservative Dentistry Government Dental College, Bangalore

<sup>4</sup> Dean and Director Government Dental College, Bangalore

### ABSTRACT

**AIM:** To know the impact on osseointegration of custom made zirconia implants in comparison to titanium *in-vivo* conditions prospective basis.

**MATERIALS AND METHODS:** Prospective observational study was approved by the ethical committee of Government dental college and research institute, Bangalore. Based on the desired sample size of a total 15 patients with bilaterally missing lower first molar were reported in the departmental interventions of prosthodontics, GDCRI, Bangalore. All subjects were considered for the study intervention. As per the SOP a commercially availed Zirconia blocks were implanted for fabricating customs, which were made by zirconia implants, tested the implants. As reliability assurance were studied as comparable with titanium implants (placebo). Further, a split mouth design was developed with zirconia as a tested a specimen on one side and titanium implants on the other side. The implant site allocations were done on the basis of randomization 2x2 procedure. Customs made zirconia implants were made by copy milling the corresponding titanium implants, size were determined by using radiographic analysis and bone mapping techniques evolved after implant both groups were evaluated with respect to bone loss, plaque index and probing depth in the different follow up period (6,12,24 months). Multivariate analysis statistical method was used to draw the inference

**RESULTS:** As per the resulted observation, the study was not found to be statistically significant between the placebo and study groups respectively ( $p>0.05$ )

**CONCLUSION:** The present study concludes that, the results were generated from the present intervention are promising in using Zirconia implants for dental applications in the future prospective. It would be useful for dental clinicians for early diagnosis.

**KEYWORDS:** Zirconia, Titanium, Osseointegration, Copymiling, Plaqueindex & Split Mouth

**Received:** Jun 01, 2017; **Accepted:** Jun 21, 2017; **Published:** Dec 09, 2017; **Paper Id.:** IJDRDDEC20172

### INTRODUCTION

Treatment with fixed prostheses supported by end osseous implants has improved the quality of life of the edentulous patient.<sup>1</sup> during the past three decades, many different materials and shapes have been proposed for dental implants. It is generally accepted that implants should be made of stable, nontoxic, and bioactive materials, so that the surrounding tissues can form an interfacial bond with the implants.<sup>2</sup> Titanium or its alloys has become a gold standard as a base for tooth reconstruction in dental implant logy, because of its mechanical strength, chemical stability and excellent biocompatibility.<sup>3</sup> There is less inflammatory response and better stabilization of soft tissues in contact with Zirconia.<sup>10,11</sup> The lower plaque retention capacity and higher affinity to osteoblasts<sup>12,13</sup>

along with the more aesthetic tooth like color have made Zirconia a viable implant material. The available documentation indicates that zirconia ceramics may be suitable material to be used as dental implants but currently the scientific clinical data for zirconia implants are not sufficient to recommend their routine clinical use nevertheless which has to be supported by clinical investigations. The aim of the present study is to compare and evaluate soft and hard tissue conditions of custom made zirconia implant and titanium implants with the null hypothesis being that there is no difference between the zirconia and titanium implant and an alternate hypothesis stating that zirconia is better and can be a viable alternative to titanium implant.

## MATERIAL & METHODS

Patients reporting to department of prosthodontics, Government Dental College and Research institute, Bangalore for replacement of bilateral missing teeth, were screened for the past 6 months. Inclusion criteria; Patients in the age group of 20 to 60 yrs with bilateral missing teeth in the same arch without any gender bias were selected. Pre operative radiographs were used to quantify the amount of available bone and patients with the same residual bone height were selected. Exclusion criteria; General contraindication to implant surgery, lack of opposing dentition, acute infection in the area, immunosuppressant or immunodepression, active periodontitis, poor oral hygiene and motivation, irradiation in the head/ neck region, bruxism, uncontrolled diabetes, pregnant/ lactating women, substance abuse, psychiatric disorders or unrealistic expectations, participation in other clinical trials interfering with present protocol having been referred only for implant placement and unable to be followed for at least one year, requiring the use of membrane at the time of implant placement, implant sites subjectively evaluated as being characterized by soft bone quality. Twenty five patients who reported to the department who met the inclusion criteria formed the sample out of which 15 patients were selected using simple random sampling procedure. Split mouth model was developed with custom made zirconia implant on one side as a trial specimen and titanium implant as control on the other side. In total 15 trial specimens and 15 controls formed the sample size. The implant site allocation was done randomly using sealed envelopes containing the randomization code. The study adhered to the principles outlined in the declaration of Helsinki on clinical research involving human subjects. A consent form was made available in regional languages. Ethical clearance from the institutional ethical committee was obtained.

## CLINICAL PROCEDURE

Pre implant assessment of patient's general health, dental status, occlusion, oral hygiene was done (Figure 1). Pre operative radiographs were used to quantify the amount of available bone and locate major anatomical features (Figure 2). Diagnostic cast was made along with standardized orthopantomograms with radiographic markers. Bone mapping and radiographs were used to ascertain the length and width of the implant.

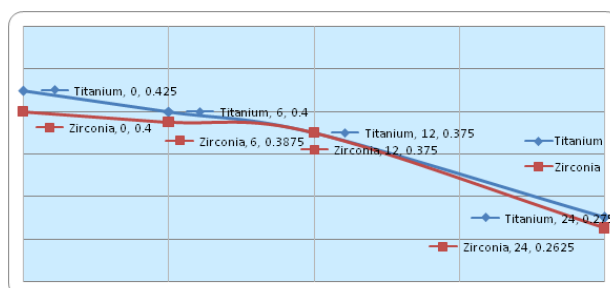
Within 10 days prior to implant placement, all patients were undergoing at least one session of oral hygiene instruction and debridement if required. All patients received single dose of prophylactic antibiotic therapy one hour prior to implant placement, 2gm of amoxicillin or 600mg clindamycin if allergic to penicillin. Patients were asked to rinse one minute prior to implant placement with 0.2% chlorhexidine mouthwash and was under local anaesthesia using lignocaine with adrenaline 1:100000. For copy milling ceramic unit from Ammannirback (Germany) was used (Figure 3). The unit consists of a mounting table with two arms. One arm consists of scanner and other arm of a drill attachment. Zirconia implant was milled in single piece by copying the titanium implant with attached abutment. On the scanning side

corresponding titanium implant with abutment attached was mounted on the table with the mounting plates and on the corresponding side Zirconia blocks were mounted. Before milling the equipment was calibrated (Figure 4). After milling, the specimen was carefully removed from the mounting plate and kept for sintering in the furnace for eight hours with a holding temperature upto 1200<sup>0</sup>C(Figure 5). Zirconia implant was cleaned ultrasonically with alcohol, water steamed and autoclaved at 134<sup>0</sup>C for 15 minutes. Single piece Zirconia implant obtained after copy milling will act as the test specimen which was compared and evaluated against the Gold Standard which is titanium acting as the control. Osteotomies were made using surgical drills after raising the flaps on both the side (Figure 6). Both zirconia and titanium implants were placed simultaneously and flaps were sutured back (Figure 7). Patients were prescribed analgesics (Ibuprofen 400mg 2 times for 5 days) and antibiotics (Amoxicillin 500mg 3 times for 5days/ Clindamycin 300mg 3 times for 5days if patients are allergic to penicillin). Patients were instructed to use chlorhexidine 0.2% mouth wash twice a day for 2 weeks, to have soft diet for 2 weeks and to avoid trauma on the surgical sites. Patients were recalled after a week for suture removal. Post implant assessment of both the group implants were constantly done (Figure 8). Radiographic evaluation was done after 6 months, 12months; 24months (Figure 9). During the same time period plaque index and probing depth was also evaluated (Figure 8). Both the group implants were loaded after 3 months (Figure 10) and both the groups were constantly evaluated.

## RESULTS

The bone to implant contact increased over the examination period for both Zirconia and Titanium implants. After four weeks of healing the mean bone implant contact was 47.7 %  $\pm$  9.1 for Titanium and 35.3 %  $\pm$  10.8 for Zirconia. After four weeks of healing the mean bone implant contact was 58.6 %  $\pm$  9.5 for Titanium and 45.3 %  $\pm$  15.7 for Zirconia. After twelve weeks of healing the mean bone implant contact was 82.9 %  $\pm$  10.7 for Titanium and 71.4 %  $\pm$  17.8 for Zirconia. No statistically significant differences in percentage, bone implant contact, existed between surfaces of Titanium and Zirconia at different time periods of 4, 8 and 12 weeks. So it was concluded that no differences in bone apposition could be observed between the two groups after healing periods of 4,8 and 12 weeks in a rabbit model. All clinical and radiographic data were tabulated for each individual and group. Summary statistics (mean and standard deviation), were calculated for each study group. A repeated measure two-way ANOVA (Analysis of Variance) was conducted using SPSS. For each clinical measure and for the radiographic measure of evaluation, the repeated measures ANOVA were conducted between the first group (Titanium) and second group (Zirconia).

## PLAQUE INDEX

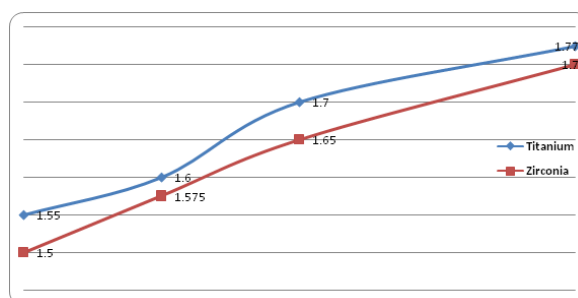


The Results in the figure shows no statistically significant difference between the groups comparing the Plaque Index.

|            | Df | SS      | MS     | F-Value | Pr(>F) | F Crit |
|------------|----|---------|--------|---------|--------|--------|
| Group      | 1  | 0.0070  | 0.0070 | 0.274   | 0.607  | 2.866  |
| Residuals  | 18 | 0.04625 | 0.0257 |         |        |        |
| Time       | 3  | 0.257   | 0.0856 | 6.58    | 0.0007 | 2.866  |
| Group*Time | 3  | 0.0008  | 0.0003 | 0.02    | 0.996  |        |
| Residuals  | 54 |         |        |         |        |        |

Repeated measures two-way ANOVA test results for Plaque Index for group-1 (Titanium) versus group-2 (Zirconia).

### PROBING DEPTH

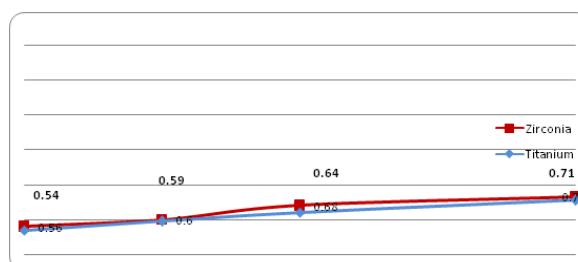


The Results in the figure shows no statistically significant difference between the groups comparing the Probing Depth.

| Source of Variation | Df | SS     | MS      | F-Value | Pr(>F)   | F Crit |
|---------------------|----|--------|---------|---------|----------|--------|
| Group               | 1  | 0.0281 | 0.02813 | 0.219   | 0.645    | 2.866  |
| Residuals           | 18 | 2.3109 | 0.12839 |         |          |        |
| Time                | 3  | 0.6438 | 0.21458 | 16.816  | 7.73e-08 | 2.866  |
| Group*Time          | 3  | 0.0031 | 0.00104 | 0.082   | 0.97     |        |
| Residuals           | 54 | 0.6891 | 0.01276 |         |          |        |

Repeated measures two-way ANOVA test results for Probing Depth for group-1 (Titanium) versus group-2 (Zirconia).

### BONE LEVEL LOSS



The Results in the figure shows no statistically significant difference between the groups comparing the Bone Level loss.

| Source of Variation | Df | SS     | MS      | F-Value | Pr(>F) | F Crit |
|---------------------|----|--------|---------|---------|--------|--------|
| Group               | 1  | 0.010  | 0.010   | 2.059   | 0.168  | 2.866  |
| Residuals           | 18 | 0.088  | 0.0048  |         |        |        |
| Time                | 3  | 0.3424 | 0.11415 | 96.071  | 2e-16  | 2.866  |
| Group*Time          | 3  | 0.0020 | 0.00068 | 0.571   | 0.636  |        |
| Residuals           | 54 | 0.0642 | 0.00119 |         |        |        |

Repeated measures two-way ANOVA test results for Bone level loss for group-1 (Titanium) versus group-2 (Zirconia).

## **DISCUSSIONS**

The present study Zirconia implants showed reduced plaque accumulation compared to Titanium implants which had higher Plaque Index <sup>2,3,4,5</sup>. The reduced Bacterial adhesion on Zirconia implants surface promotes reformation of the biologic width and therefore the formation of a mucosal seal that stops early marginal bone resorption <sup>10, 14, 15</sup>. Thus further clinical studies on Zirconia implants have to be conducted to investigate if Zirconia implants have clinical significant values compared with well established data on Titanium implants. The presently evaluated results are in accordance to findings of Titanium implants after corresponding investigation periods and Zirconia implants after functional loading <sup>10,8,6,9</sup>.

## **CONCLUSIONS**

The present study concludes that, the results were generated from the present intervention are promising in using Zirconia implants for dental applications in the future prospective. It would be useful for dental clinicians for early diagnosis.

## **REFERENCES**

1. Cibirka RM, Razzoog M, Lang BR. Critical evaluation of patient responses to dental implant therapy. *J Prosthet Dent* 1997; 78:574-81.
2. Att W, Kurun S, Gerds T, et al. Fracture resistance of single tooth implant-supported allceramic restorations: an in vitro study. *J Prosthet Dent*, 2006; 95: 111-6.
3. Langhoff JD, Voelter K, Scharnweber D, Schnabelrauch M, Schlottig F, Hefti T, Kalchofner K, Nuss K, von Rechenberg B. Comparison of chemically and pharmaceutically modified titanium and zirconia implant surfaces in dentistry: a study in sheep. *Int J Oral Maxillofac Surg*. 2008;37:1125-32
4. Wenz HJ, Bartsch J, Wolfart S, Kern M. Osseointegration and clinical success of zirconia dental implants: a systematic review. *Int J Prosthodont*. 2008; 21:27-36.
5. Bianco PD, Ducheyne P, Cuckler JM. Local accumulation of titanium released from a titanium implant in the absence of wear. *J Biomed Mater Res* 1996; 31:227–34.
6. Weingart D, Steinemann S, Schilli W, et al. Titanium deposition in regional lymph nodes after insertion of titanium screw implants in maxillofacial region. *Int J Oral Maxillofac Surg* 1994; 23:450–2.
7. Akagawa Y, Ichikawa Y, Nikai H, Tsuru H. Interface histology of unloaded and early loaded partially stabilized zirconia endosseous implant in initial bone healing. *J Prosthet Dent*. 1993; 69:599-604.
8. Ichikawa Y, Akagawa Y, Nikai H, Tsuru H. Tissue compatibility and stability of a new zirconia ceramic in vivo. *J Prosthet Dent*. 1992; 68:322–326.
9. Warashina H, Sakano S, Kitamura S, et al. Biological reaction to alumina, zirconia, titanium and polyethylene particles implanted onto murine calvaria. *Biomaterials*. 2003;24:3655–3661
10. Degidi M, Artese L, Scarano A, Perrotti V, Gehrke P, Piattelli A. Inflammatory infiltrate, microvessel density, nitric oxide

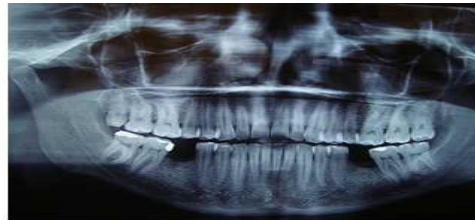
*synthase expression, and proliferative activity in peri-implant soft tissues around titanium oxide healing caps. J Periodontol 2006; 77:73-80.*

11. Rimondini L, Cerroni L, Carrasi A, Torricelli P. Bacterial colonization of zirconia ceramic surfaces: an in vitro and in vivo study. *Int J Oral Maxillofac Implants* 2002; 17:793-8.
12. Scarano a, Piatelli M, Caputi S, FaveroGA, Piattelli A. Bacterial adhesion on commercially pure titanium and zirconium oxide disks: an in vivo human study. *J Periodontol* 2004; 75:292-6.
13. Depprich R, Ommerborn M, Zipprich H, Naujoks C, Handschel J, Wiesmann H-P, et al. Behaviour of osteoblastic cells cultured on titanium and structured zirconia surfaces. *Head Face Med* 2008;4:29

## APPENDIX –I



**Figure 1: Bilateral Missing First Molar**



**Figure 2: Panoramic View Showing Missing 36 And 46**



**Figure 3: Titanium Implant with Attached Abutment**



**Figure 4: Mounting Plates Attached to Theceramil Unit**



**Figure 5: Single Piece Milled Zirconia Implant**



**Figure 6: Titanium Implant Placed in 36 Region**



**Figure 7: Corresponding Single Piece Zirconia Implant**



**Figure 8: Split Mouth Design Implants**





**Figure 9: Zirconia Implant  
After 2 Weeks**



**Figure 10: Titanium Implant  
After 2 Weeks**



**Figure 11: Panoramic View After 3 Months of  
Implant Placement**



**Figure 12: Implants Loaded After 3 Month**

